XORAZM VOHASI SHAROITIDA G‘O‘ZA ILDIZ TIZIMINI RIVOJLANISHIGA O‘G‘IT BERISH ME’YORINING TA’SIRINI BAHOLASH

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ОЦЕНКА ВЛИЯНИЯ НОРМЫ ВНЕСЕНИЯ УДОБРЕНИЙ НА РАЗВИТИЕ КОРНЕВОЙ СИСТЕМЫ ХЛОПЧАТНИКА В УСЛОВИЯХ ХОРЕЗМСКОГО ОАЗИСА

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ASSESSMENT OF THE EFFECT OF FERTILIZER APPLICATION RATES ON THE DEVELOPMENT OF COTTON ROOT SYSTEM UNDER THE CONDITIONS OF THE KHOREZM OASIS

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Annotatsiya: *Ushbu tadqiqotda Xorazm vohasi sharoitida g‘o‘za ildiz tizimining rivojlanishiga ta’sir etuvchi o‘g‘it berish me’yorlari o’rganildi. Tajriba natijalari, g’o’za ildiz tizimi rivojlanishining optimal me’yorlarini aniqlashga yordam berdi. Olingan natijalarga ko’ra, Xorazm vohasining agroklimatik sharoitida o’g’itlash usullarining samaradorligini aniqlashga hamda paxtachilikda hosildorlikni oshirishda ilmiy asos yaratadi.*

Kalit so'zlar: *g'o'za, ildiz tizimi, o'g'it me'yorlari, NPK, agrotexnika, hosildorlik, tuproq, agroklimatik sharoitlar, o'simlik fiziologiyasi.*

Аннотация: *В данном исследовании изучались нормы внесения удобрений, влияющие на развитие корневой системы хлопчатника в Хорезмском оазисе. Результаты эксперимента позволили определить оптимальные нормы развития корневой системы хлопчатника. Полученные результаты дают научную основу для определения эффективности методов удобрения в агроклиматических условиях Хорезмского оазиса и повышения продуктивности возделывания хлопчатника.*

Ключевые слова: *хлопчатник, корневая система, нормы удобрений, NPK, агротехника, урожайность, почва, агроклиматические условия, физиология растений.*

Abstract: *This study examined the rates of fertilizer application that affect the development of the cotton root system in the Khorezm oasis. The results of the experiment allowed us to determine the optimal rates of development of the cotton root system. The results obtained provide a scientific basis for determining the effectiveness of fertilization methods in the agroclimatic conditions of the Khorezm oasis and increasing the productivity of cotton cultivation.*

Keywords: *cotton, root system, fertilizer rates, NPK, agricultural technology, productivity, soil, agroclimatic conditions, plant physiology.*

Introduction. The Republic of Uzbekistan ranks among the leading countries in the world for cotton production. Cotton is a strategic crop that plays a vital role in the economy, particularly in the textile industry, livestock farming, oil and fat production, and food security. Achieving stable and high yields in the country is made possible through scientifically based agro-technological practices [6; 9].

The root system of cotton plays a crucial role in supplying the plant with water and nutrients. In particular, under the unique agro-climatic conditions of the Khorezm region, the full development of the root system is one of the key factors influencing yield. The region's sharp temperature fluctuations and relatively saline, low-fertility soils require specific agro-technical measures for successful cultivation. Variations in fertilizer application rates directly affect root structure, which in turn influences the overall growth, development, and yield of the cotton plant.

The relevance of this study lies in the current need for rational resource use, especially in increasing the efficiency of mineral fertilizers, reducing their negative environmental impact, cutting costs, and maintaining crop yields at a stable level.

It has been proven by researchers that, based on natural soil fertility alone, it is possible to harvest 12–14 centners of cotton per hectare. When cotton is adequately nourished with nitrogen, phosphorus, and potassium fertilizers, yields can reach 25–35 centners or more. Currently, the cotton crop absorbs only about 40% of the nitrogen fertilizer applied to the soil. The nutrient requirements of cotton vary depending on its growth stages. The plant needs nutrients not only during the growing season but also during the formation of fruit buds [1].

As seen from the above, in order to achieve the planned yields from agricultural crops, it is necessary to apply mineral fertilizers in a differentiated manner and at scientifically justified times, which ensures the successful attainment of target yields.

Research objective. To study the effect of different fertilizer application rates on the development of the root system of cotton under the conditions of the Khorezm region and to develop an optimal fertilization scheme.

Research tasks:

- To study the depth, mass, and structure of the cotton root system;
- To compare the effects of various NPK fertilizer rates on root development;
- To recommend the most optimal fertilization scheme from both economic and agro-technical perspectives.

Object and subject of the research. The object of the research is the cotton variety *Khorezm-127*, and the subject is the impact of various fertilizer rates on the development of its root system.

Research methods. The experiment involved ecological monitoring (observation, comparison, and analysis), and physical and chemical analysis of soil and water (using Tyurin and Kachinsky methods, EC-Hanna meter for electrical conductivity). Biometric indicators of plant development, field experiments, and phenological observations were carried out according to the guidelines “Methods of Conducting Field Experiments” (UzPITI, 2007).

During the experiment, the depth of the root system, dry mass weight, number and length of lateral roots were measured. Data were statistically analyzed using the ANOVA method.

The experiment was conducted during 2023–2024 on the experimental fields of Urgench State University. The cotton variety *Khorezm-127* was sown. The experiments were carried out using a randomized block design with four replications, in accordance with international scientific-methodological recommendations. The following fertilizer application rates were chosen as experimental variants.

Soil and climatic conditions of the region. The Khorezm oasis is located in the western part of Uzbekistan, within the Amu Darya valley, and is characterized by a unique climate. During the summer months, air temperatures rise to +40–45°C, while winters are relatively mild. The vegetation period lasts approximately 200–220 days. The soils are predominantly medium loamy, irrigated, light to moderately fertile with low salinity levels. Although the organic matter content is low, proper irrigation and agro-technical practices can lead to high yields [3; 8].

Experimental scheme

Variant	Fertilizer Rate (kg/ha)	Type of fertilizer
V1 – control	Without fertilizers	–
V2	150:100:100 kg/ha N, P, K	(Urea ($(NH_2)_2CO$), Phosphoric acid (H_3PO_4), Potassium oxide (K_2O))
V3	200:140:140 kg/ha N, P, K	(Urea ($(NH_2)_2CO$), Phosphoric acid (H_3PO_4), Potassium oxide (K_2O))
V4	250:180:180 kg/ha N, P, K	(Urea ($(NH_2)_2CO$), Phosphoric acid (H_3PO_4), Potassium oxide (K_2O))

Analysis and results. Cotton (*Gossypium spp.*) is one of the most important industrial crops in Uzbekistan's agriculture, serving not only as a source of fiber but also as a raw material for oil production, animal feed, and the chemical industry. Cotton productivity and fiber quality are largely influenced by its physiological characteristics and scientifically based agrotechnical measures.

Cotton is a thermophilic and light-loving plant with a deep root system that undergoes specific growth and development stages during the vegetation period. These stages include germination, seedling formation, budding, flowering, boll formation, and ripening — each requiring specific agro-climatic conditions and technical interventions.

The root system of cotton can penetrate depths of 1.5–2 meters, allowing the plant to absorb water and nutrients from deeper soil layers. Photosynthesis in the leaves is particularly active under 12–14 hours of daily sunlight. The optimal temperature range for growth and productivity is between 25–30°C.

The transpiration coefficient ranges from 350 to 500, indicating that cotton has a high water requirement, especially during active growth stages. Adequate irrigation and moisture reserves are crucial. In terms of nutrition, cotton has high demands for nitrogen, phosphorus, and potassium, while micronutrients such as boron, manganese, molybdenum, and zinc also play significant roles.

Cotton agrotechnology involves a series of practices aimed at achieving high yields and quality fiber. These include:

- Land Preparation: Deep plowing (30–35 cm) is done in autumn, followed by cultivation in spring. To improve soil fertility, 10–15 tons/ha of well-decomposed manure is applied.
- Seed Sowing: Optimal soil temperature for sowing is 12–14°C, typically occurring from late April to early May. The seeding rate is 40–45 kg/ha, with row spacing of 60–90 cm and intra-row spacing of 10–15 cm.
- Crop Maintenance: During the growing season, 2–3 inter-row cultivations are conducted, along with weed control, timely irrigation, and fertilization. Irrigation is carried out 4–5 times, with each session using 600–800 m^3/ha of water. Fertilizer application rates include nitrogen – 200–250 kg/ha, phosphorus – 100–140 kg/ha, and potassium – 100–140 kg/ha.
- Pest and Disease Control: Major pests include cotton bollworms, spider mites, and thrips, managed using both biological and chemical methods. Common diseases include verticillium wilt, fusarium wilt, and root rot.
- Harvesting: Harvesting is done manually or mechanized in 1–3 rounds. Average yields are 25–35 centners/ha, while the use of advanced agrotechnology and improved varieties can increase yields to 45–50 centners/ha [4; 5].

Cotton variety "Khorezm-127" – Description and field trials. The cotton variety *Khorezm-127* is a medium-staple type developed by the scientists of the Khorezm branch of the Uzbek Scientific Research Institute of Cotton Breeding. It was created by crossing variety 163-F with S-9062, followed by multiple single plant selections and backcrossing.

The authors of the variety include J. Yuldoshev and others. In 2002, the variety was registered in the State Register for use in the Khorezm region.

Morphological characteristics: The cotton plant has a pyramidal shape, well-suited for inter-row cultivation and mechanical harvesting. The stem grows upright, reaching a height of 90–120 cm. It is green with moderate pubescence. Fruiting branches emerge from the 5th–6th nodes and branch out in 1.0–1.5 types. The leaves are large, 3–5 lobed, and dark green in color. The bolls weigh 6.0–6.5 grams on average, are egg-shaped, elongated, smooth, and hairy. They open well, which is convenient for harvesting.

The flowers are medium-sized with a pale yellow color. The bolls are large and egg-shaped. The seeds are light green to grayish and covered with fuzz. The weight of 1,000 seeds ranges from 122–132 grams. The oil content is about 24.5%.

Fiber quality indicators:

- Ginning outturn: 36.5–38.4%;
- Fiber length: 34.5–36.0 mm;
- Metrical number: 6100 (164);
- Breaking strength: 4.4–4.6 g/tex;
- Relative breaking length: 26.2 g/tex;
- Micronaire: 4.2.

According to the fiber quality standards, it belongs to **Type IV**. Based on data from the Fiber Quality Center, the fiber shows the following metrics:

- Micronaire: 4.2–4.4;
- Fiber length (VIII scale): 1.08–1.12 inches;
- Fiber length (COD): 34.5–36.0 mm;
- Relative breaking strength: 26.0–27.3 g/tex.

Compared to the standard variety *175-F* commonly planted in the Khorezm region, *Khorezm-127* matures 7–13 days earlier and can yield 45–50 centners per hectare.

Field experiments were conducted at the experimental fields of Urgench State University during the 2023–2024 growing seasons. The experimental plot covered 8 hectares, arranged in 4 variants with 4 replications each. Each plot had 8 rows with a row spacing of 60 cm.

Mineral fertilizers were applied in pure form:

- Nitrogen: Urea ($(NH_2)_2CO$);
- Phosphorus: Ammophos ($2H_3PO_4 + 3NH_3 = NH_4H_2PO_4 + (NH_4)_2HPO_4$);
- Potassium: Potassium chloride (K_2O).

The cotton was irrigated using the furrow irrigation method. Soil moisture was maintained at 65-75-70% of the field capacity, with irrigation applied five times based on the 1-3-1 schedule.

Table 1

The Effect of Fertilizer Rates on the Development of Cotton Root System

Variant	Root Depth (cm)	Dry Root Mass (g)	Number of Lateral Roots (pcs)	Length of Lateral Roots (cm)
1V– control	22	12	8	9.1
2V	29	18	13	14.7
3V	33	24	18	18.3
4V	35	26	19	18.8

According to the data in Table 1, all indicators were the lowest in the control variant (Variant 1). Without the application of fertilizers, the root depth reached only 22 cm and the dry root mass was 12 g. In Variant 2, with the application of NPK fertilizers at a rate of 150:100:100 kg/ha, root depth increased to 29 cm, and other parameters also showed positive development.

The optimal variant was Variant 3 (200:140:140 kg/ha), in which all root development indicators were the highest: root depth reached 33 cm, dry root mass was 24 g, the number of lateral roots was 18, and their total length was 18.3 cm. Although Variant 4 showed a slight improvement in some parameters, the difference compared to Variant 3 was not statistically significant. Moreover, the application of higher fertilizer rates was found to be economically and environmentally inefficient (Table 1).

The results of the study indicate that the rate of fertilizer application is a critical factor in the optimal development of the cotton root system. Both under- and over-application of fertilizers may slow root growth or damage soil structure. Throughout the experiment, Variant 3 provided the best results, indicating that this specific rate is optimal under the agro-climatic conditions of the Khorezm region from both agronomic and economic perspectives.

The findings are consistent with previous studies (Qodirov, 2019; Norqulov, 2020). Excessive fertilizer application does not necessarily lead to greater root development and may even result in harmful effects such as salt accumulation and soil structure deterioration. In practice, this leads to economically unjustified increases in agro-technical costs.

According to N. Ibragimov, plants absorb only about 40% of the nitrogen fertilizers applied, while 37.9% is wasted and more than 22% remains in the soil. This 40% is considered the fertilizer uptake coefficient and should not be confused with fertilizer use efficiency [2].

Conclusion: A deep understanding of the physiological characteristics of cotton, adaptation to ecological and agro-climatic conditions, and the implementation of scientifically based agro-technical practices are essential for achieving high efficiency in cotton production. The plant’s deep root system, sensitivity to light, and high demand for water and nutrients require precise agro-technical planning. Therefore, an integrated approach based on the climate and soil conditions of each region is necessary.

The rate of fertilizer applied to cotton has a direct impact on root system depth, root mass, number, and length of lateral roots. The NPK fertilizer rate of 200:140:140 kg/ha is recommended as the optimal variant. Overapplication of fertilizer negatively affects soil health and is economically inefficient. The results of

this research highlight the potential for achieving high yields and rational resource use under the specific conditions of the Khorezm region.

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